FINAL REPORT
INCREMENTS A, B, E AND G

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO
EEAP PROJECT NO. 208

VOLUME I. EXECUTIVE SUMMARY

PREPARED FOR:

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ABBREVIATIONS USED

SIR	=	Savings Investment Ratio
yr.	=	year
MBtu	=	Million British Thermal Units
ECAM	=	The Energy Conservation and Management Program
EEAP	=	The Energy Engineering Analysis Program
ECIP	=	The Energy Conservation Investment Program
BEIP	=	The Boiler Efficiency Improvement Program
CWE	=	Current Working Estimate
EMCS	=	Energy Management Control Systems
Btu	=	British Thermal Unit
S.F.	=	Square Feet
PDB	=	Project Development Brochures
RAAP	=	Ravenna Army Ammunition Plant
LAP	=	Load Assembly Pack
Misc.	=	Miscellaneous
AEI	=	Annual Energy Index
gal.	=	gallons
kVA	=	Volt x Amp x 1000
kWh	=	Watt x Hours x 1000
HDD	=	Heating Degree Days
U.S.	=	United States
Vol.	=	Volume
N/A	=	Not Applicable
L.L.	=	Load Line
H.V.A.C.	=	Heating Ventilation and Cooling
DHW	=	Domestic Hot Water
FY	=	Fiscal Year
RDF	=	Refuse Derival Fuels
avg.	=	average
UA	=	Product of U-value and area
CFM	=	Cubic Foot per Minute
lbm	=	pound of mass
min.	=	minute
hr.	=	hour
sec.	=	seconds
U	=	1/R (U-value) (Btu/hr/SF/^{o}F)
R	=	Thermal Resistance (SF-^{o}F-hr/Btu)
BLDG	=	Building
SIOH	=	Supervision, Inspection and Overhead
Ins.	=	Insulation

ABSTRACT

The report herein is part of a major energy plan to reduce energy consumption among Army facilities. There are four such plans which comprise the Army Energy Program.

1. Army Energy Plan (AEP)
2. Army Facilities Energy Plan (AFEP)
3. MACOM Facilities Energy Plans
4. Installation Facility Energy Plans (IFEP)

This report is a product of the Army Facilities Energy Plan. The plan's goals are:

- To reduce baseline FY 1975 total facilities energy consumption (BTU) 20 percent by FY 1985 and 40 percent by FY 2000.
- To develop the capability to use synthetic gases by FY 2000.
- To reduce heating oil consumption by 75 percent by FY 2000.

Five programs have been established to help achieve the above goals. The programs are:

1. The Energy Engineering Analysis Program (EEAP)
2. The Energy Conservation Investment Program (ECIP)
3. The Energy Conservation and Management Program (ECAM)
4. Solid Fuels Conversion Program
5. The Boiler Efficiency Improvement Programs (BEIP)

This report is the third report resulting from the Energy Engineering Analysis Program (EEAP) for the Ravenna Army Ammunition Plant. The first report (Phase I) consisted of a presentation of data gathered from the plant. The second report (Phase II) made recommendations to improve plant energy consumption. The third and fourth reports (Phase III and IV) consists of the information developed in Phase II with complete programming documents (Project Development Brochures (PDB) and DD 1391 forms) for the recommended projects.

The work was divided into increments which can be studied. The increments funded for the Plant were: Increment "A" - Building Modifications, Increment "B" - Energy Distribution Systems and Energy Monitoring and Control Systems (EMCS), Increment "E" - Installing Central Boiler Plants or Solid Fuel Conversion of Existing Plants, Increment "F" - Modifications to Systems and Operations and Summarized Projects Identified in Increments A, B, C, E and G (Increment "F" begins when Increments A, B, E and G are complete), and Increment "G" - projects identified in Increments A and B which do not meet the Energy Conversation Investment Program (ECIP) guidelines for funding. This report is organized into five sections: Executive Summary (Vol. I), Narrative Report (Vol. II), Appendix (Vol. III). Programming Documents (Vol. IV) and Separately Bound Items (Vol. V).

Projects identified in Increments "A" and "B" are to be funded by the Energy Conservation and Management Program (ECAM). However, projects in these increments were evaluated according to ECIP requirements (DAEN-MPO-O, 10 August 1982). Increment "E" projects were evaluated according to ETL-1110-3-332 Economic Studies.

RAVENNA ARMY

AMMUNITION PLANT

I. INTRODUCTION

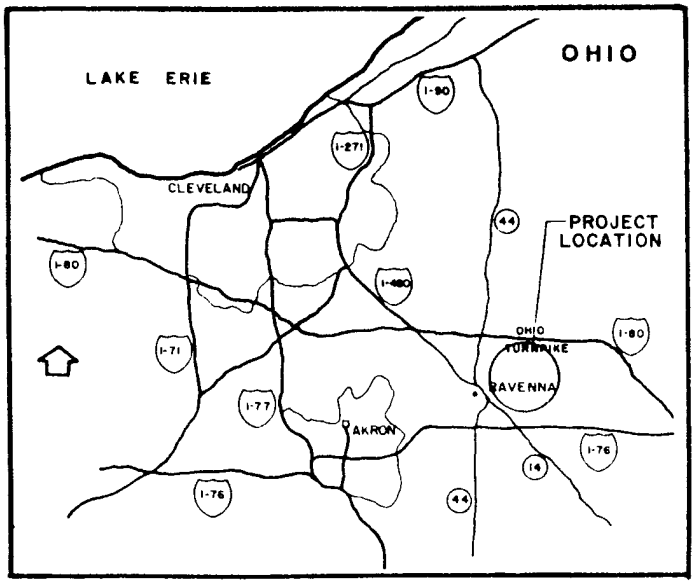
A. General Description

The Ravenna Army Ammunition Plant (RAAP) is an inactive load, assemble and pack plant (LAP). It is located in Northeastern Ohio 35 miles southeast of the city of Cleveland, 28 miles east of Akron, and 25 miles west of Youngstown. (See Figure 1-1) The plant covers 21,419 acres and is divided into load line areas, underground storage igloo areas, magazines and plant administration areas. Construction of the plant was begun in 1941 and completed in 1942. The plant has had three periods when it was active: World War II, the Korean conflict and the Vietnam conflict. Ravenna Arsenal, Inc. is the operating contractor for the plant.

Figure 1-1 shows the site plan of the plant and the following table gives a breakdown of the number of buildings and their type for the plant.

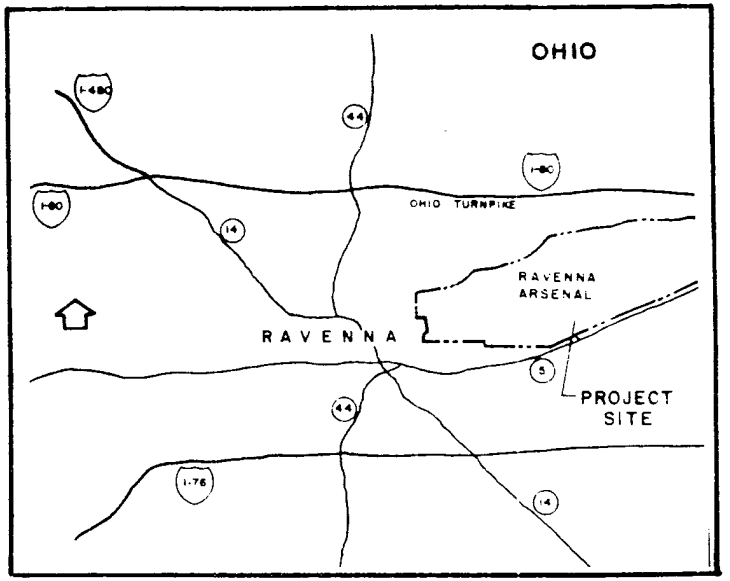
SCHEDULE OF BUILDINGS FOR RAVENNA ARMY AMMUNITION PLANT

Area	Major Buildings	Support Buildings	Total
Load Line 1	12	36	48
Load Line 2	14	24	38
Load Line 3	10	26	36
Load Line 4	13	9	22
Load Line 5	8	14	22
Load Line 6	11	16	27
Load Line 7	8	12	20
Load Line 8	8	10	18
Load Line 9	12	37	49
Load Line 10	10	19	29
Load Line 11	8	12	20
Load Line 12	7	8	15
Administration Area	31	14	45
Dehumidified Warehouses			21
Misc. Buildings			53
Storage Buildings (Block and Areas)			939
			1,400



LOCATION MAP
NOT TO SCALE

FIGURE 1-1



VICINITY MAP
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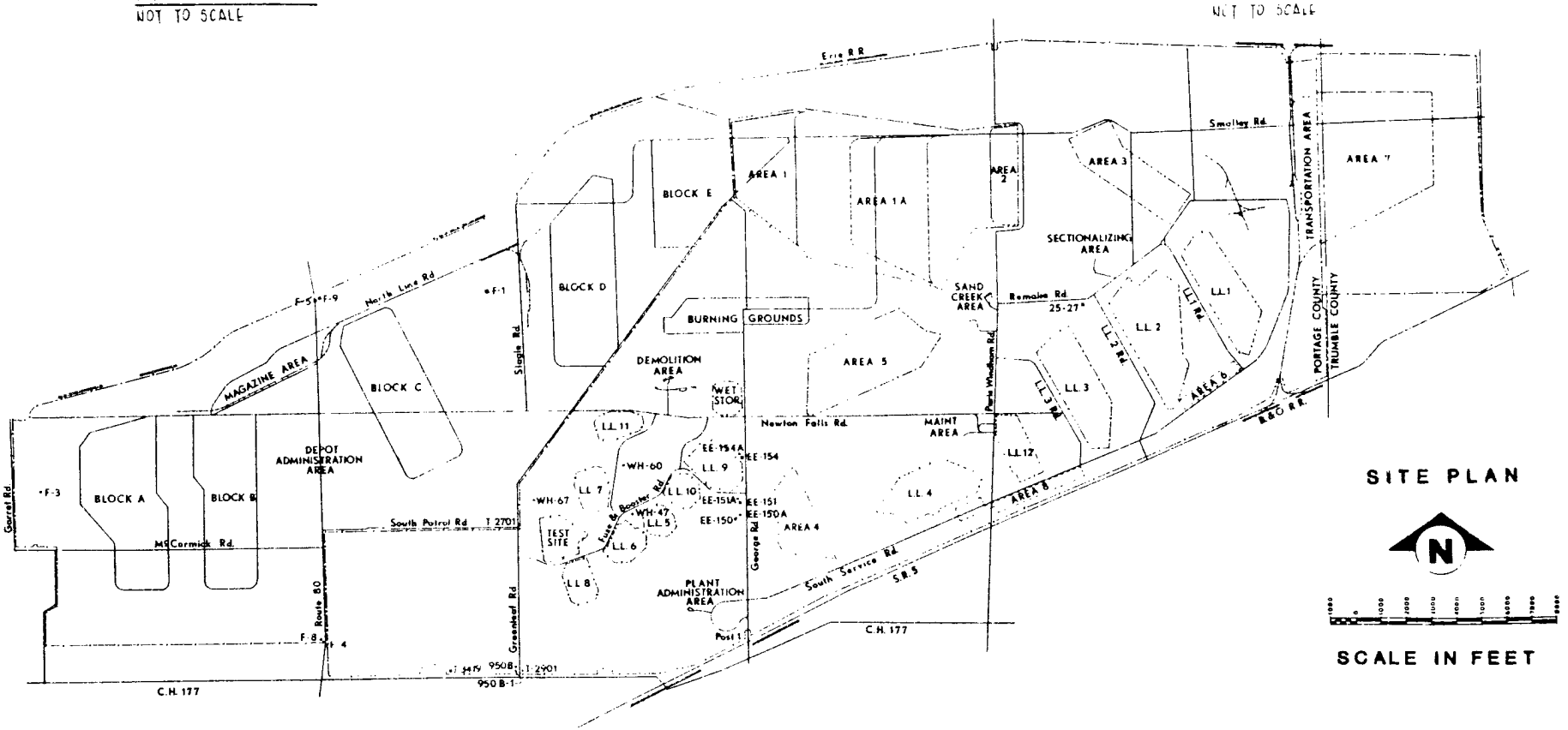


SITE PLAN

II. EXISTING ENERGY CONSUMPTION

There are four sources of energy consumed at the plant: fuel oil #6, fuel oil #2, kerosene and electricity. Table 1-1 lists the yearly consumption of those fuels along with their associated MBtu values and costs. Figures 1-2 thru 1-4 depict this information graphically for the fiscal years 1975-81. Fuel data was supplied by the facility engineers. The general decrease in consumption is due to the scaling down of the plant activities and energy conservation efforts by the facility engineer.

Using the fuel information it was determined that the total Annual Energy Index (AEI) for the plant is 125,000 Btu/SF. The AEI is the ratio of the total annual energy consumed by the plant to the total area of the buildings that consume the energy (122×10^9 Btu/976,000 SF = 125,000 Btu/SF). This is shown in Figure 1-5 and is within the normal range for the nation. Although the AEI is not meant for comparison with large plants, since the plant is inactive, it does give relative standing of the buildings in the plant with other buildings in the nation. Additionally, the Army has produced a document giving the average AEI for 16 building classifications in 7 climatic conditions. ETL-1110-3-295, 10 October 1978, gives 226,700 Btu/SF/YR as the average of all facilities for FY 1975. This figure does not actually give a target value for the plant as it is the average from a wide variety of facilities. However, it is noted that Ravenna Army Ammunition Plant is below the average.

Also, Executive Order 12003, dated 20 July 1977, established energy conservation goals for new and existing Federal facilities. These goals are to reduce energy usage by 45 percent in new buildings and 20 percent in existing buildings, on a per square foot basis, in 1985 when compared to 1975 levels. The intent of this EEAP study is to provide a major portion of this energy reduction.

Figures 1-6 thru 1-8 give the percentage of each energy source consumed on a Btu basis and cost basis for the fiscal year 1981.

There are three types of buildings located throughout the plant: office buildings, maintenance buildings and dehumidified warehouses. Typical consumption on a square foot basis is given in Table 1-2.

HISTORICAL UTILITY USAGE

TABLE 1-1

FUEL OIL #6: Year	Usage (gal.)	MBtu	Cost ($)
Fiscal Yr. 1981	348,349	52,145	$202,103
Fiscal Yr. 1980	312,923	46,842	131,967
Fiscal Yr. 1979	328,771	49,214	115,951
Fiscal Yr. 1978	355,169	53,168	123,515
Fiscal Yr. 1977	365,990	54,788	123,196
Fiscal Yr. 1976	352,544	52,775	116,655
Fiscal Yr. 1975	419,782	62,838	139,027

FUEL OIL #2: Year	Usage (gal.)	MBtu	Cost ($)
Fiscal Yr. 1981	90,915	12,609	$ 76,069
Fiscal Yr. 1980	91,912	12,747	58,971
Fiscal Yr. 1979	96,197	13,342	39,982
Fiscal Yr. 1978	102,396	14,202	35,315
Fiscal Yr. 1977	62,805	8,711	20,260
Fiscal Yr. 1976	102,527	14,220	30,541
Fiscal Yr. 1975	119,518	16,576	32,737

KEROSENE: Year	Usage (gal.)	MBtu	Cost ($)
Fiscal Yr. 1981	2,867	398	$ 2,394
Fiscal Yr. 1980	2,927	406	1,180
Fiscal Yr. 1979	2,895	401	1,167
Fiscal Yr. 1978	3,249	450	1,147
Fiscal Yr. 1977	2,993	415	1,044
Fiscal Yr. 1976	8,938	1,239	2,910
Fiscal Yr. 1975	4,541	630	1,177

ELECTRICITY: Year	Usage (kWh/1000)	MBtu	Total Demand (kVA)	Cost ($)*
Fiscal Yr. 1981	3,241	37,596	9,542	$153,731
Fiscal Yr. 1980	3,251	37,712	9,214	135,266
Fiscal Yr. 1979	3,308	38,373	9,328	118,061
Fiscal Yr. 1978	3,296	38,234	N/A	103,212
Fiscal Yr. 1977	3,254	37,746	N/A	92,501
Fiscal Yr. 1976	3,683	42,723	N/A	82,813
Fiscal Yr. 1975	4,032	46,771	10,818	90,724

*Note: Cost for electricity includes demand charges. The actual cost for electricity (kWh) is stepped according to the amount of energy used and the peak kVA registered each month. The December 1982 demand rate was 10.23 $/kVA. Additionally, the present average kWh charge is .03593 $/kWh which includes the present $.021554/kWh fuel adjustment charge. The cost used for dollar saving calculations resulting from energy projects results from the rate of the last step of energy used (ie .027859 $/kWh) which computes to 2.40 $/MBtu. This cost also includes a 3% discount allowed to the plant for service at 23,000 volts.

BTU VALUE OF FUELS

Fuel Oil #6 = 149,690 Btu/Gallon
Fuel Oil #2 = 138,700 Btu/Gallon
Kerosene = 138,700 Btu/Gallon
Electricity = 11,600 Btu/kWh

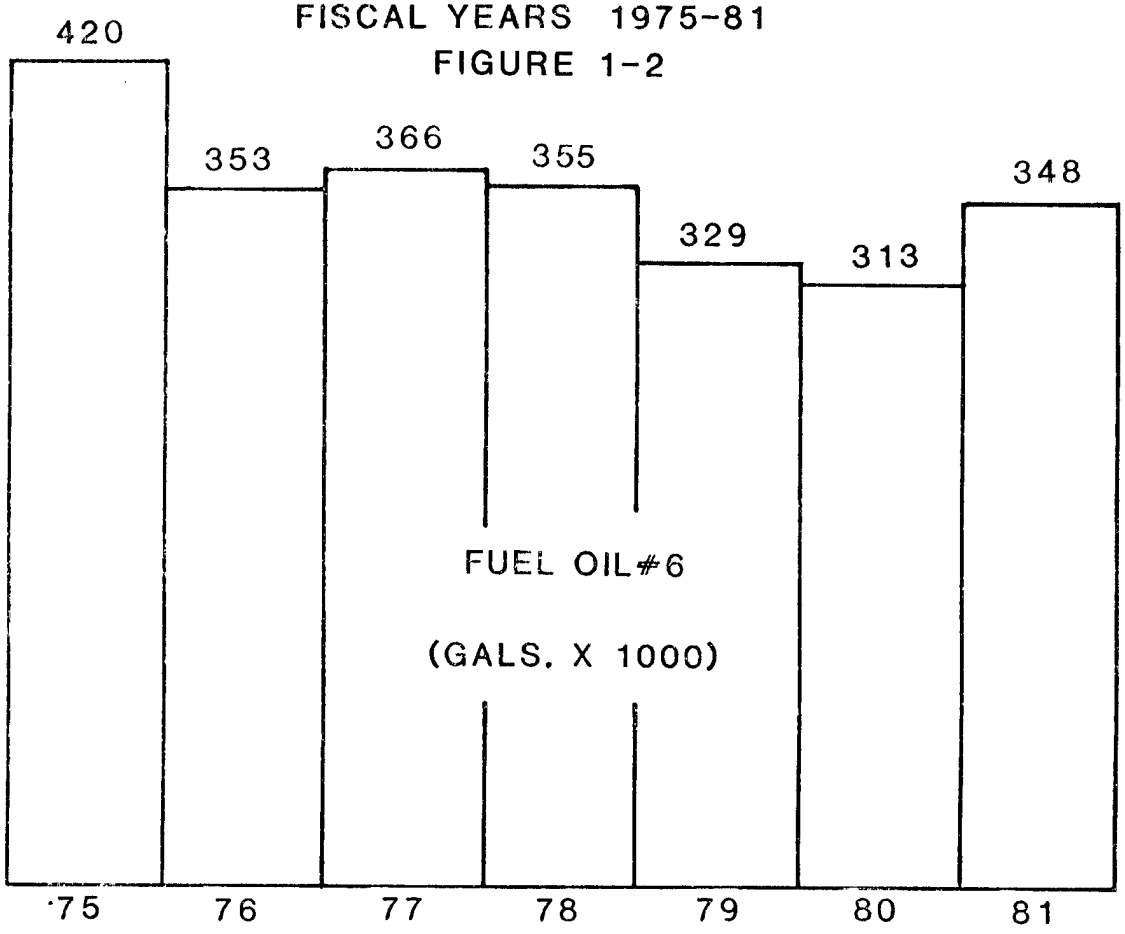
NOTE: MBtu = Btu x 10^6

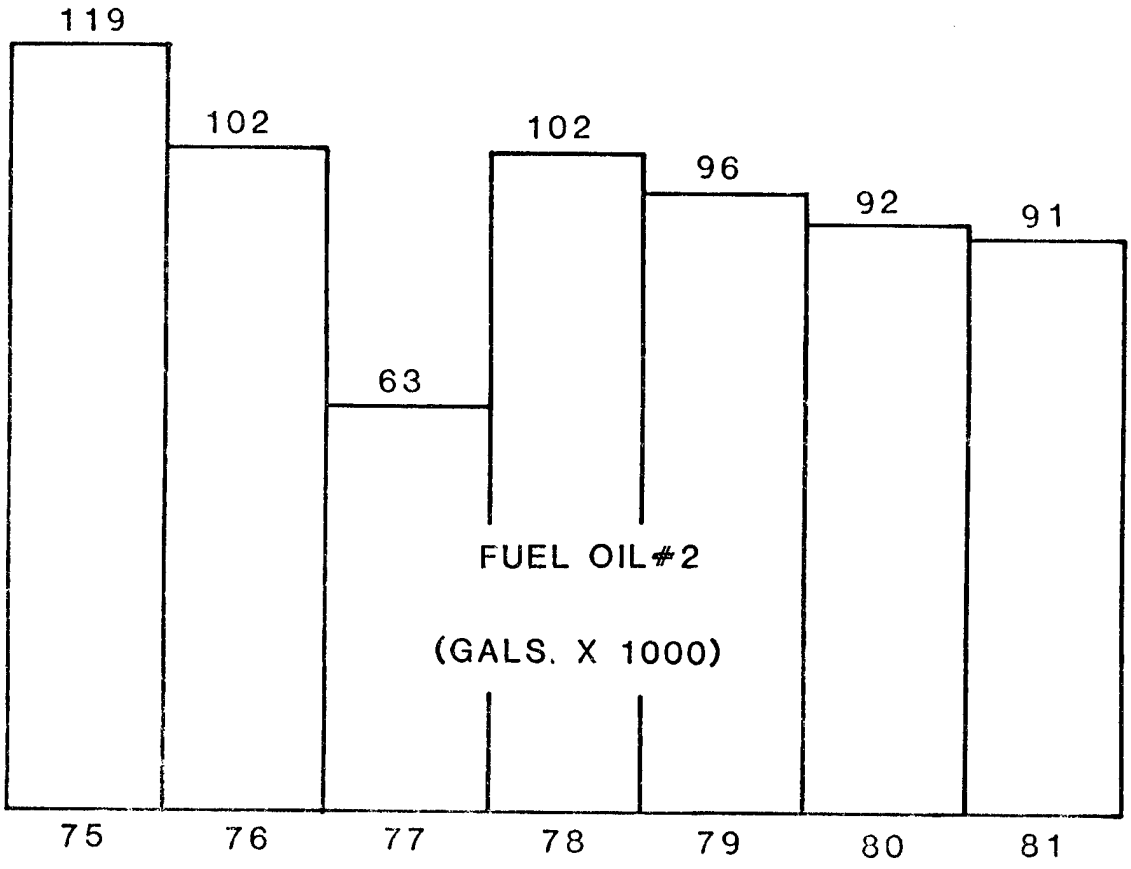
RAVENNA ARMY AMMUNITION PLANT

ANNUAL ENERGY CONSUMPTION

FISCAL YEARS 1975-81

FIGURE 1-2



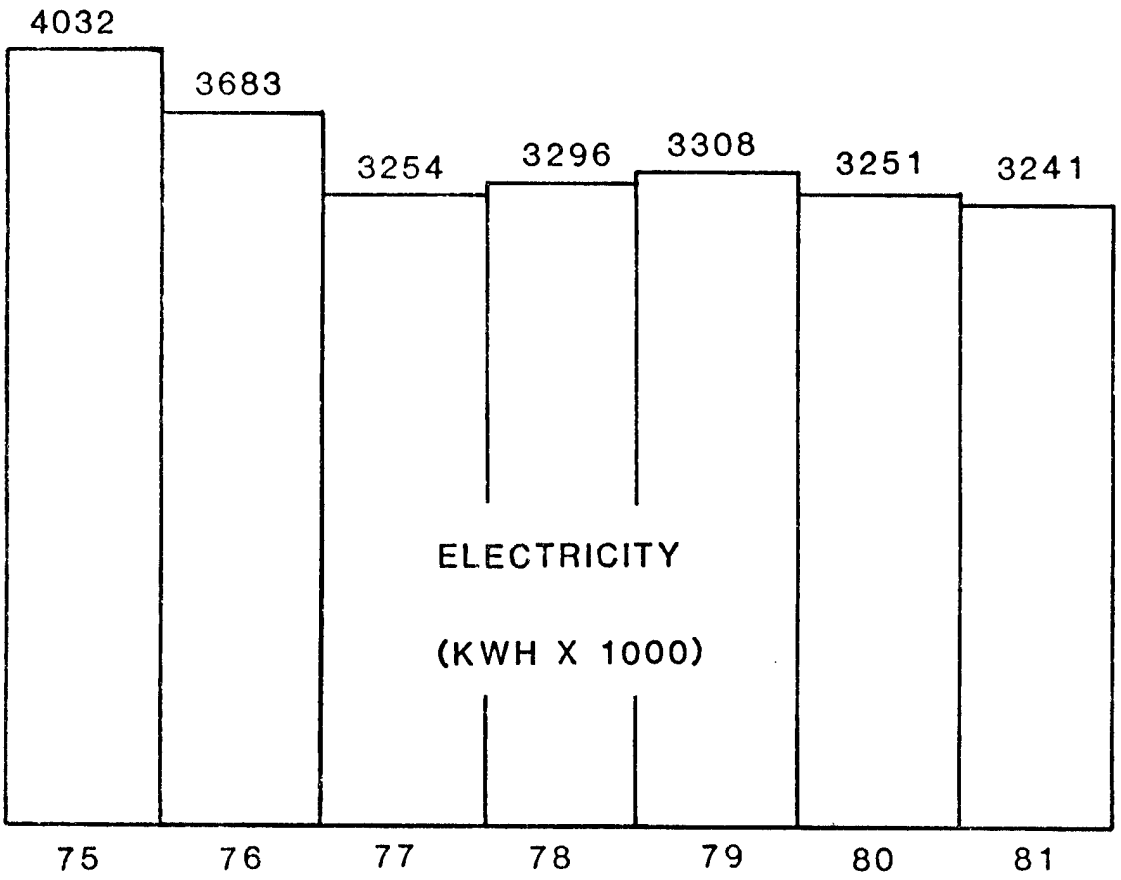


RAVENNA ARMY AMMUNITION PLANT

ANNUAL ENERGY CONSUMPTION

FISCAL YEARS 1975-81

FIGURE 1-3

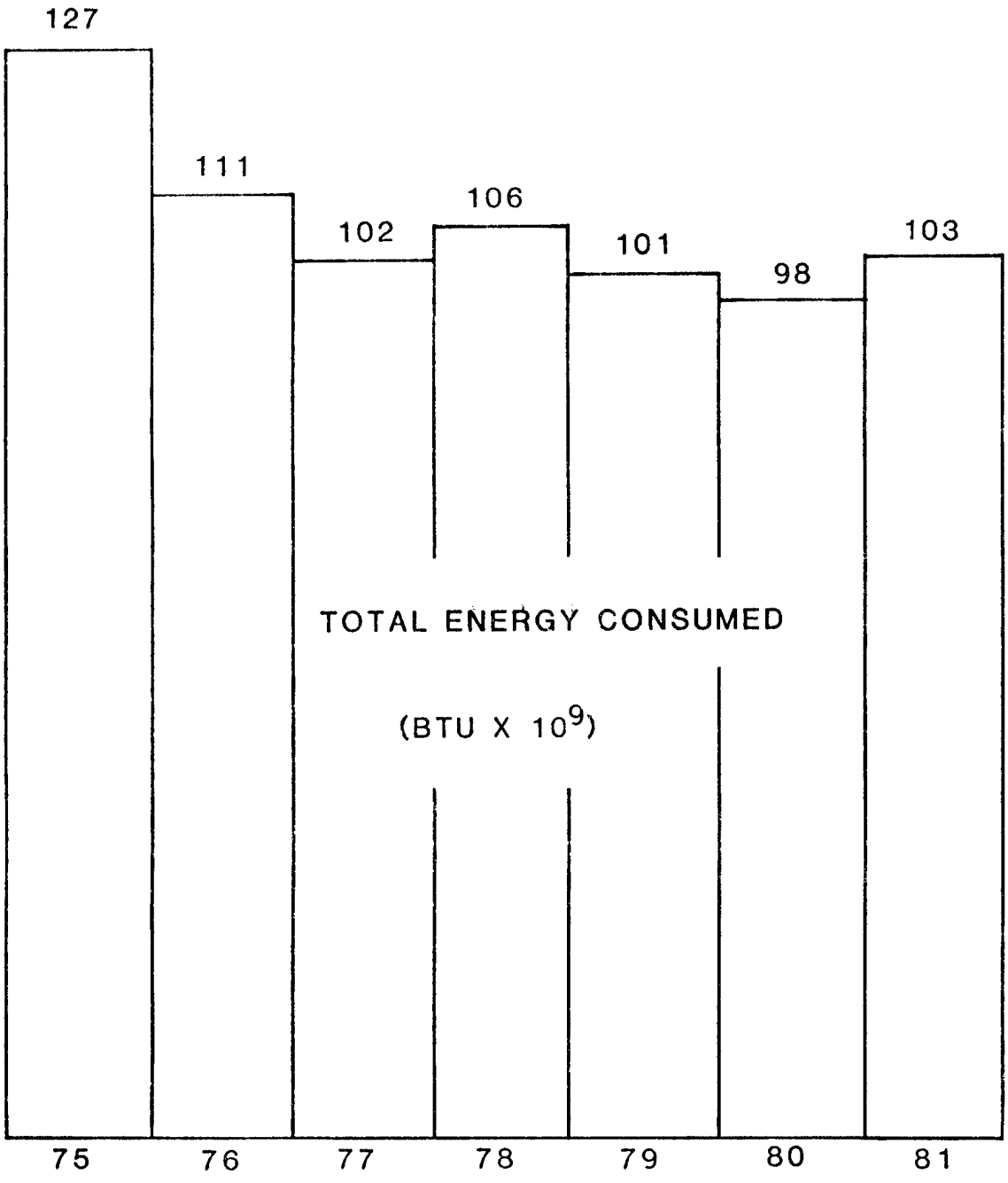


RAVENNA ARMY AMMUNITION PLANT

ANNUAL ENERGY CONSUMPTION

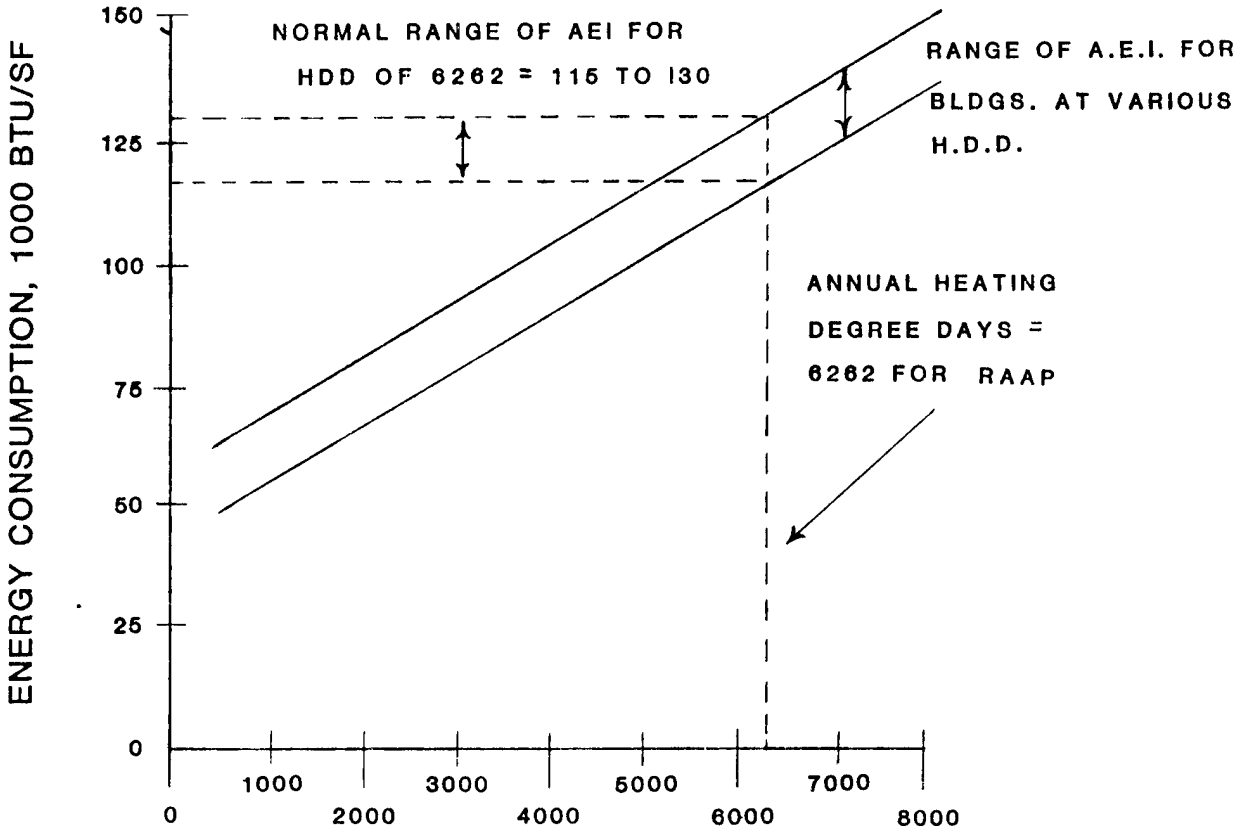
FISCAL YEARS 1975-81

FIGURE 1-4



ANNUAL ENERGY INDEX NORMS

THROUGHOUT THE NATION



TOTAL AEI FOR RAAP = 125,000 BTU/SF

HEATING AEI FOR RAAP = 179,000 BTU/SF

NOTE: AEI NORMS ARE TAKEN FROM

INSTRUCTIONS FOR ENERGY AUDITORS

PREPARED BY U.S. DEPARTMENT OF ENERGY

FIGURE 1-5

RAVENNA ARMY AMMUNITION PLANT

FY 81 ENERGY SOURCES

(% OF ANNUAL MBTU USAGE)

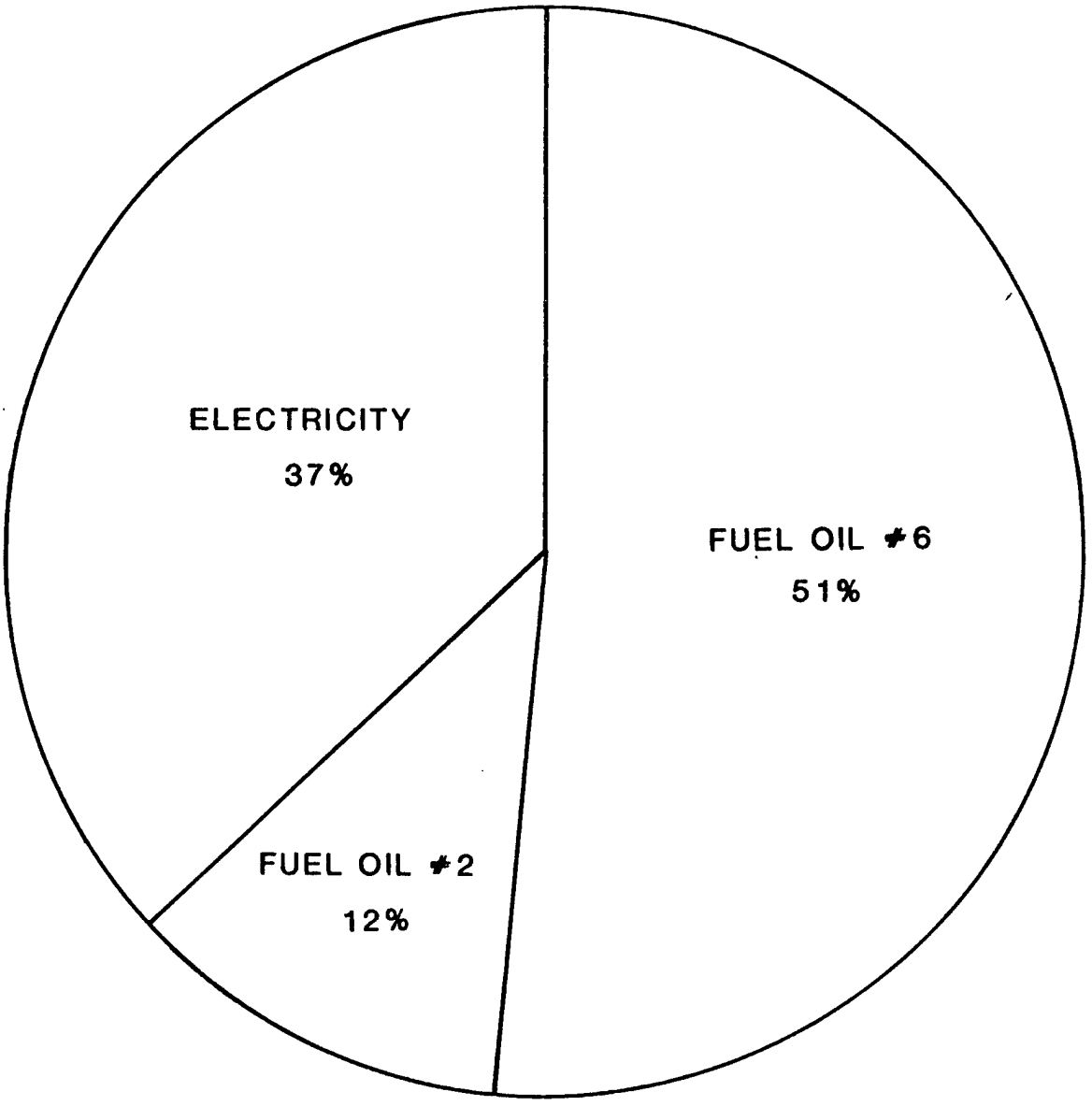


FIGURE 1-6

RAVENNA ARMY AMMUNITION PLANT

FY 81 ENERGY COST

(% OF ANNUAL COST)

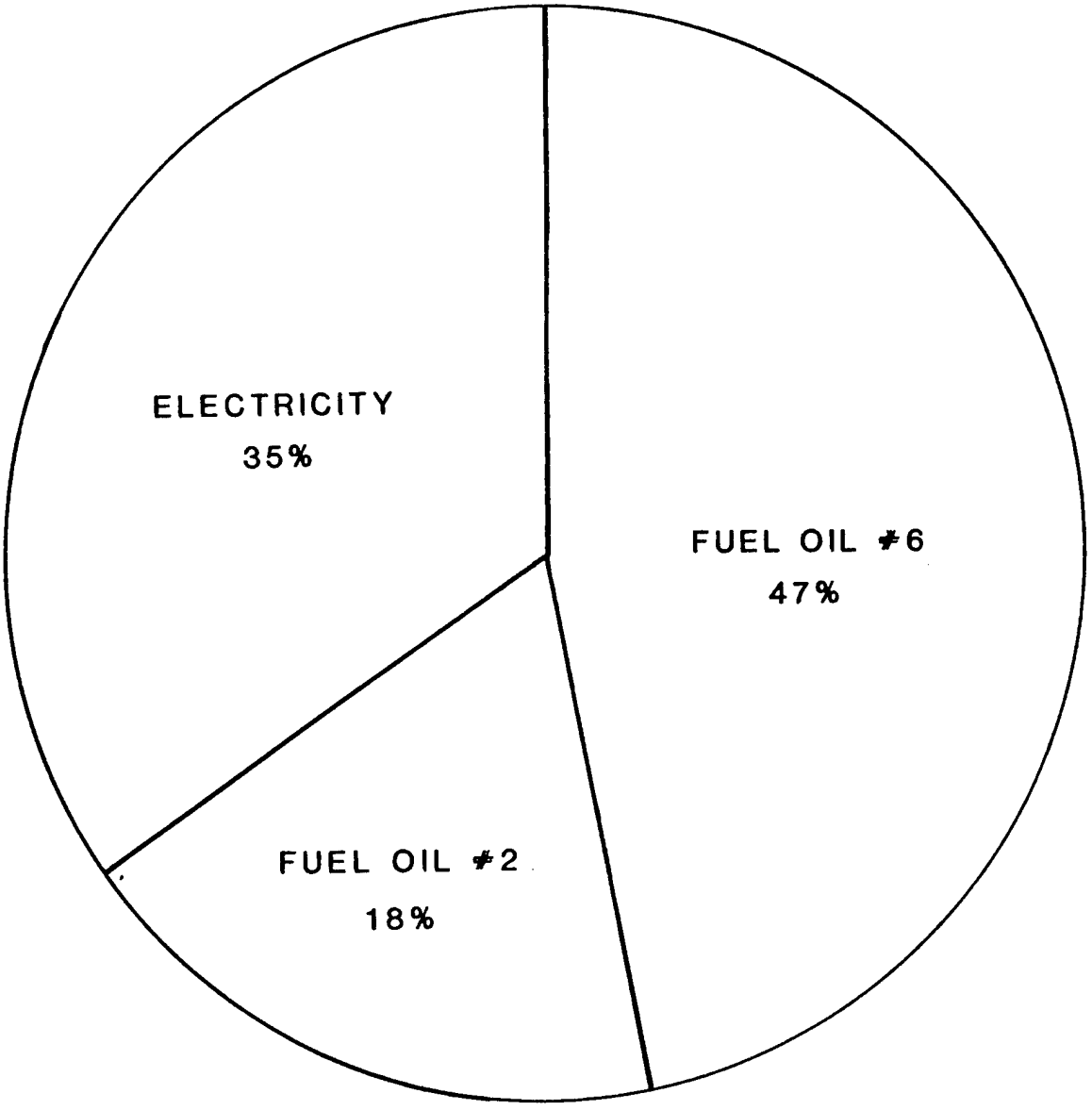


FIGURE 1-7

RAVENNA ARMY AMMUNITION PLANT

ELECTRICAL DISTRIBUTION

(%Of Annual Usage)
FY 81

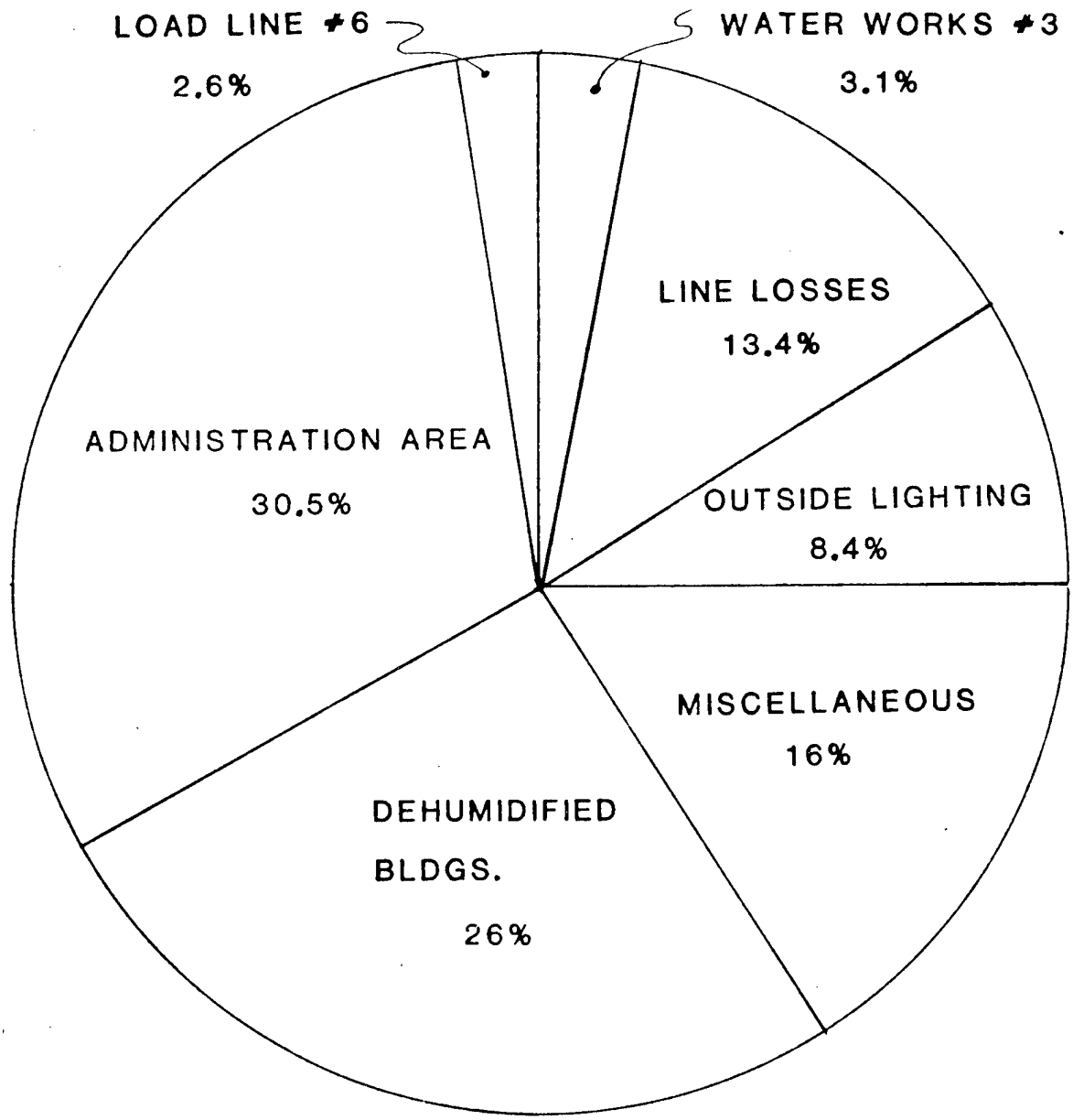


FIGURE 1-8

TABLE 1-2

TYPICAL BUILDING CONSUMPTION

OFFICE BUILDING:

Electric	-	24,300	Btu/SF/YR
Steam	-	9,580	Btu/SF/YR
Total	-	33,880	Btu/SF/YR

MAINTENANCE BUILDING:

Electric	-	5,890	Btu/SF/YR
Steam	-	134,900	Btu/SF/YR
Total	-	140,790	Btu/SF/YR

DEHUMIDIFIED WAREHOUSE:

Electric	-	12,400	Btu/SF/YR
Steam	-	0	
Total	-	12,400	Btu/SF/YR

III. ENERGY CONSERVATION MEASURES

As a result of the data gathered during Phase I of the project, a number of energy conservation measure were studied.

Projects are considered under five categories (A, B, E, F and G) or Increments as described in the Scope of Work for the Energy Engineering Analysis Program (EEAP). The Scope of Work is included in the Appendix. Increment "A" and "B" projects are evaluated using Energy Conservation Investment Program (ECIP) criteria. However, funding for the project is to be obtained using the ECAM program as Ravenna Army Ammunition Plant is a government owned contractor operated (GOCO) facility. Projects which are energy saving but which do not qualify under ECIP criteria are recommended as Increment G projects. Increment F projects involve policy changes and will be studied separately from this study. The scheduled date to begin Increment "F" for Ravenna is April 1983. Other Increments (C and D) discussed in the Scope were not funded for this study.

Table 1-3 gives a list of projects investigated. Table 1-4 lists the actual projects which qualify under the ECIP criteria and are being proposed as such. The additional energy saving projects which are being recommended under Increment "G" are listed in Table 1-5 . Projects that were investigated but not recommended are listed in Table 1-6 .

Project results are listed in sections IV thru X. A narrative description of each project can be found in Vol. II and project calculations are found in Vol. III of this report. Programming documents are located in Vol. IV.

TABLE 1-3

ENERGY CONSERVATION MEASURES INVESTIGATED

PROJECT	PROJECT #
Roof/Ceiling Insulation	A1-a
Wall Insulation	A1-g
Floor Insulation	N/A
Crawlspace Insulation	G-1
Condensate Insulation	A1-d
Valve Insulation	A1-e
DHW Heater Insulation	A1-f
Light Insulation	G-2
Overhead Door Insulation	A1-b
Window Insulation	A1-c
Frame Wall Insulation	N/A
Door/Window Weatherstripping	A1-h
Storm Windows	N/A
Reducing Lighing Levels (Delamping)	A2-c
Night Setback	B-1
Demand Limiting	B-1
Radiator Controls	A2-b
Down-Blowers	A2-a
Condensate Return Line (L.L.6)	G-4
Time Clocks for Domestic Hot Water Heater Controls	N/A
Boiler Fan Replacement	G-3
Heat Pumps	N/A

TABLE 1-4

ECIP PROJECTS DEVELOPED

Project

INCREMENT "A"

- A1 Insulation/Weatherstripping
  - a. Roof/Ceiling Insulation
  - b. Overhead Door Insulation
  - c. Window Insulation
  - d. Condensate Line Insulation
  - e. Valve Insulation
  - f. DHW Heater Insulation
  - g. Wall Insulation
  - h. Weatherstripping
- A2 HVAC Modifications
  - a. Down-Blowers
  - b. Radiator Controls
  - c. Delamping

INCREMENT "B"

- B1 Energy Monitoring Control System (EMCS)

TABLE 1-5

OTHER ENERGY CONSERVATION PROJECTS

(INCREMENT G)

G1 Crawlspace Insulation

G2 Light Insulation and Ballast Replacement

G3 Boiler Fan Replacement

G4 Condensate Return Line

TABLE 1-6

PROJECTS INVESTIGATED BUT NOT RECOMMENDED

Storm Windows

Heat Pump Systems

Time Clocks for Domestic Hot Water Heater Controls

Floor Insulation

Frame Wall Insulation

IV. INCREMENT "A" PROJECTS

Increment "A" projects involve modifying, improving or retrofitting existing buildings, including family housing, to include architectural and structural features, HVAC systems, plumbing systems, interior or exterior building and parking facilities lighting.

Table 1-7 lists projects that were identified under Increment "A" with their associated annual energy savings (MBtu/YR), analysis date annual dollar savings, analysis date construction, design, supervision inspection and overhead costs (SIOH), total net discounted savings and savings to investment ratios (SIR). Calculations leading to these values are rather lengthy and can be found in Volume III by referring to the table of contents.

TABLE 1-7

INCREMENT "A" PROJECT SUMMARY

	Projects	Analysis Date Construction Cost $	SIOH Cost $	Design Cost $	Energy Savings MBtu/YR.	Analysis Date Annual Savings $	Total Net Discounted Savings $	SIR
A1	Insulation/Weatherstripping							
	a. Roof/Ceiling Insulation	31060	1553	1864	2525	14316	233517	7.5
	b. Overhead Door Insulation	1495	75	90	167	825	12577	8.4
	c. Window Insulation	2850	143	171	446	2744	46338	16.3
	d. Condensate Line Insulation	18710	936	1123	5720	24825	349285	18.7
	e. Valve Insulation	13800	690	828	762	3307	46531	3.4
	f. Domestic Water Heater Ins.	1050	53	63	247	593	8495	8.1
	g. Wall Insulation	33530	1677	2012	2013	10596	166869	5.0
	h. Weatherstripping	27900	1395	1674	873	3789	53309	1.9
	TOTAL	130395	6522	7825	12753	60995	916921	7.0
A2	HVAC Modifications							
	a. Down-Blowers	30500	1525	1830	6275	33308	395801	13.0
	b. Radiator Controls	45675	2284	2741	1607	6974	85436	1.9
	c. Delamping	470	24	28	712	4200	53507	114.0
	TOTAL	76645	3833	4599	8594	44482	534744	7.0

V. INCREMENT "B" PROJECTS

Increment "B" projects involve utilities and energy distribution systems, EMCS for building and distribution systems, and existing energy plants.

Table 1-8 lists projects that were identified under Increment "B" with their associated annual energy savings (MBtu/YR), analysis date annual dollar savings, analysis date construction, design, supervision inspection and overhead costs (SIOH), total net discounted savings and savings investment ratios (SIR). Calculations leading to these values are rather lengthy and can be found in Volume III by referring to the table of contents.

TABLE 1-8

INCREMENT "B" PROJECT SUMMARY

	Project	Analysis Date Construction Cost $	SIOH Cost $	Design Cost $	Energy Savings MBtu/YR.	Analysis Date Annual Savings $	Total Net Discounted Savings $	SIR
B1	Energy Monitoring and Control System	158287	7914	9497	3631	27421	301143	1.9

VI. INCREMENT "C" PROJECTS

Increment "C" projects involve renewable energy projects, principally solar and biomass and determining the feasibility of utilizing solar and biomass for space heating, space cooling, domestic hot water or process heat, or combinations thereof. Renewable energy sources include such items as biomass, hydro, wind, solar, tide, and wave propagation. Refuse incineration is considered to be a renewable energy source, but is not included in this increment. Geothermal and nuclear sources, although not strictly renewable energy sources, shall be considered among the alternatives. A study of Increment "C" projects was not funded in this contract.

VII. INCREMENT "D" PROJECTS

The purpose of Increment "D" projects is to determine the feasibility of new cogeneration and solid waste plants utilizing solid fuels, supplemented, as feasible, with refuse derived fuels (RDF) and waste oil fuels. This study shall be performed for the entire installation to include family housing. A study of Increment "D" projects was not funded in this contract.

VIII. INCREMENT "E" PROJECTS

Increment "E" projects determine the feasibility of installing central boiler plants serving all or discrete parts of each military facility. The Ammunition Plant has 8 centrally located boiler plants. However, due to scaled down operations at the plant, only one of the 8 boiler plants is being utilized. This plant is used to heat all buildings located in the Administration Area. Therefore, the Increment "E" study concerns this boiler plant only. Since the information gathered at the initial site investigation indicates that further centralization of existing plants is impractical, an engineering report and economic analysis of converting the existing active central plant to solid fuels was prepared instead of a central plant analysis. Programming documents are not required (DD 1391 and PDB's Forms).

Recommendations

The present plant is fired with #6 fuel oil. The boiler was originally designed in 1941 to burn coal, but in 1974 was converted to use fuel oil for fuel. Any conversions to solid alternate fuels should include complete replacement of existing boilers.

Alternate fuel sources considered are : Coal, Refuse Derived Fuels (RDF) and Wood. RDF could be used in conjunction with coal. However, classifying and fluffing are additional operations that would be involved when using RDF as a fuel. Wood could also be used in conjunction with coal, but its moderate heating valve would require a vast harvesting of acreage (20 tons per day avg.) to meet the heating requirements of the plant. Additionally, storage and handling of wood is more costly than that of other solid fuels.

Coal is readily available and is considered as a most realistic and abundant energy source in Ohio. Therefore, coal is considered the most practical solid energy source for the alternate fuel.

Tables 1-9 and 1-10 show the results of the analysis. Since the life cycle present worth of the coal plant (3,673,929) is less than that of the oil plant (3,782,715), the coal plant should be built as soon as possible. Additionally, Volume III of this report shows the effect of project timing on the replacement. The most economical time to replace the plant is in 1993 but delaying construction until this time will only increase the amount of money paid for fuel oil and therefore increase the total life cycle costs.

TABLE 1-9
EXISTING OIL FIRED PLANT
REPLACEMENT ANALYSIS

YEAR N	FISCAL YEAR	MAINT COSTS	OPERAT. COSTS	ANNUAL COSTS	P/F DISCOUNT FACTOR	PRESENT VALUE	SUM OF PV
1	1983	50000	234530	284530	.954	271441	271441
2	1984	50000	253292	303292	.867	262954	534395
3	1985	50000	273555	323555	.788	254961	789356
4	1986	50000	174085	224085	.717	160668	950024
5	1987	50000	188011	238011	.652	155183	1105207
6	1988	140000	203051	343051	.592	203086	1308293
7	1989	50000	219295	269295	.538	144880	1453173
8	1990	50000	236838	286838	.489	140263	1593436
9	1991	50000	255785	305785	.445	136074	1729510
10	1992	50000	276247	326247	.405	132130	1861640
11	1993	50000	298346	348346	.368	128191	1989831
12	1994	140000	322213	462213	.334	154379	2144210
13	1995	50000	347990	397990	.304	120988	2265198
14	1996	50000	375829	425829	.276	117528	2382726
15	1997	50000	405895	455895	.251	114429	2497155
16	1998	50000	438366	488366	.228	111347	2608502
17	1999	50000	473435	523435	.208	108874	2717376
18	2000	140000	511309	651309	.189	123097	2840473
19	2001	50000	552213	602213	.172	103580	2944053
20	2002	50000	596390	646390	.156	100836	3044889
21	2003	50000	644101	694101	.142	98562	3143451
22	2004	50000	695629	745629	.129	96186	3239637
23	2005	50000	751279	801279	.117	93749	3333386
24	2006	140000	811381	951381	.107	101797	3435183
25	2007	50000	876291	926291	.097	89850	3525033
26	2008	50000	946394	996394	.088	87682	3612715
27	2009	50000	1022105	1072105	.08	85768	3698483
28	2010	50000	1103873	1153873	.073	84232	3782715

TABLE 1-10

PROPOSED COAL PLANT
LIFE CYCLE COST ANALYSIS

YEAR N	FISCAL YEAR	MAINT COSTS	OPERAT. COSTS	ANNUAL COSTS	P/F DISCOUNT FACTOR	PRESENT VALUE	SUM OF PV
1	1983	50000	234530	284530	.954	271441	271441
2	1984	50000	253292	303292	.867	262954	534395
3	1985	1711000	425062	2136062	.788	1683216	2217611
4	1986	85550	63370	148920	.717	106775	2324386
5	1987	85550	66538	152088	.652	99161	2423547
6	1988	85550	69864	155414	.592	92005	2515552
7	1989	85550	73357	158907	.538	85491	2601043
8	1990	85550	77024	162574	.489	79498	2680541
9	1991	256650	80875	337525	.445	150198	2830739
10	1992	85550	84918	170468	.405	69039	2899778
11	1993	85550	89163	174713	.368	64294	2964072
12	1994	85550	93621	179171	.334	59843	3023915
13	1995	85550	98302	183852	.304	55891	3079806
14	1996	85550	103217	188767	.276	52099	3131905
15	1997	256650	108377	365027	.251	91621	3223526
16	1998	85550	113795	199345	.228	45450	3268976
17	1999	85550	119484	205034	.208	42647	3311623
18	2000	85550	125458	211008	.189	39880	3351503
19	2001	85550	131730	217280	.172	37372	3388875
20	2002	85550	138316	223866	.156	34923	3423798
21	2003	256650	145231	401881	.142	57067	3480865
22	2004	85550	152492	238042	.129	30707	3511572
23	2005	85550	160116	245666	.117	28742	3540314
24	2006	85550	168121	253671	.107	27142	3567456
25	2007	85550	176527	262077	.097	25421	3592877
26	2008	85550	185353	270903	.088	23839	3616716
27	2009	256650	194620	451270	.08	36101	3652817
28	2010	85550	204351	289901	.073	21162	3673979

IX. INCREMENT "F" PROJECTS

The purpose of the work under Increment F is:

A. To provide recommendations for modifications and changes in system operation which are within the Facilities Engineer funding authority and management control.

B. To summarize and prioritize all energy conservation measures and projects from Increment A, B, E, and G for the use of the Installation Commander and Facilities Engineer in developing their energy management plans.

Increment "F" has been funded for this study. However, this increment is not scheduled to begin until Increments A, B, E, and G are completed. Scheduled completion date for Increments A, B, E, and G studies is 25 April, 1983.

X. INCREMENT "G" PROJECTS

Increment "G" projects are those feasible energy saving projects developed in Increments "A" and "B" which do not qualify under the ECIP criteria.

ECIP projects must produce a Savings to Investment Ratio (SIR) greater than one. Additionally, each project is to have a construction cost equal to or greater than $100,000.

Table 1-11 lists projects that were identified under Increment "G" with their associated annual energy savings (MBtu/YR), analysis date annual dollar savings, analysis date construction, design, supervision inspection and overhead costs (SIOH), total net discounted savings and savings to investment ratios (SIR). Calculations leading to these values are rather lengthy and can be found in Volume III by referring to the table of contents.

TABLE 1-11

INCREMENT "G" PROJECT SUMMARY

	Projects	Analysis Date Construction Cost $	SIOH Cost $	Design Cost $	Energy Savings MBtu/YR.	Analysis Date Annual Savings $	Total Net Discounted Savings $	SIR
G1	Crawlspace Insulation	12860	643	772	231	1002	14094	1.1
G2	Light Insulation and Ballast Replacement	7010	351	421	115	592	7979	1.1
G3	Boiler Improvements	6000	300	360	1825	7921	97026	16.2
G4	Condensate Line	45000	2250	2700	573	4171	74794	1.6

XI MOBILIZATION ORDER PROJECTS

A. Executive Summary

The Ravenna Army Ammunition Plant is in a standby or inactive status. The overall mission of the plant is to load, assemble and pack ammunition for war oriented use. Since the U.S. is not presently engaged in war activities, no production of ammunition is being accomplished, and the majority of the buildings are not being utilized, therefore using no energy. However, if the plant was to receive a mobilization order and ammunitions production was to begin, some of these inactive buildings would be used for production which would have a prominent impact on facility energy usage. Therefore, certain projects should be outlined for these inactive buildings, in the event the mobilization order occurs, so that they can be made more energy efficient and be utilized as quickly as possible.

The many varying factors affecting the analysis of projects pertaining to the inactive buildings, make it impossible to evaluate the projects with any degree of certainty. While energy savings (Btu's/Yr) can be readily calculated, it would be meaningless to try and guess the mobilization date in order to determine fuel costs and escalation rates as well as what type of fuel is to be used. Additionally, the impossibility of knowing how long a building will remain active after the mobilization order is received, further complicates project evaluations and viability. It would be impractical to implement projects that do not pay for themselves or whose benefits are not greater than their costs due to the fact that the buildings would not be used during the projects amortization period. This situation would occur if the buildings became active, projects were implemented, and then the mobilization order withdrawn causing the building to become inactive again before the benefits of the project outweighed the costs. This would result in money being wasted on the project. Therefore, only the most readily justifiable projects are identified in this section. They are to be implemented on the buildings which are affected by a mobilization order and determined to be active for the mobilization period. These projects also produce the most energy savings per dollar invested and are the easiest to implement (construction time). Construction time is an important factor because the buildings should be brought up to operating level as quick as possible as it may not be advantageous to consider energy conservation project during the mobilization period.

Two projects have been identified as the best energy conserving projects for buildings affected by a mobilization order. They involve the insulation of 780,125 S.F. of roof area and 104,580 S.F. of wall area. It is estimated that the roof project would save 94,638 MBtu/Yr at an October 1982 reference implementation cost of $312,000. Additionally, the wall insulation project would save an estimated 15,317 MBtu/Yr with an October 1982 reference implementation cost of $78,435. Using the October 1982 implementation cost and fuel costs as a reference (since the project is not to be funded until a mobilization order is received) the SIR for the roof project would be 18.54. The SIR for the wall project would

be 11.94. These ratios are mentioned to show that the projects are viable projects based on current costs. However, the ratios would need to be recalculated when the mobilization order is received and project viability would need to be redetermined based on actual costs. Volume II and Volume III contain more information pertaining to the buildings affected by a mobilization order.

XII. ENERGY AND COST SAVINGS

Table 1-12 presents annual project savings allocations for proposed projects and Table 1-13 shows base-wide consumption after project implementation in fiscal year 1985. Table 1-14 predicts energy costs for fiscal years 1984 through 1987. The projected MBtu usage of 76,447 yeilds a 40.8% reduction over the FY1975 consumption of 127,000 MBtu. This reduction exceeds the goal of a 20% reduction by FY1985 set forth in the Army Facility Energy Plan.

TABLE 1-12

PROJECT SAVINGS

Project			Analysis Date Annual $ Saved	Annual MBtu Saved
Increment A				
A1	Insulation/Weatherstripping			
	a.	Roof/Ceiling Insulation	14,316	2525
	b.	Door Insulation	825	167
	c.	Window Insulation	2744	446
	d.	Condensate Line Insulation	24,825	5720
	e.	Valve Insulation	3307	762
	f.	DHW Heater Insulation	593	247
	g.	Wall Insulation	10,596	2013
	h.	Weatherstripping	3789	873
		Total	60,995	12,753
A2	HVAC Modifications			
	a.	Down-Blowers	33,308	6275
	b.	Radiator Controls	6,974	1607
	c.	Delamping	4,200	712
		Total	44,482	8594
Increment B				
B1	EMCS		27,421	3631
Increment G				
G1	Crawlspace Insulation		1002	231
G2	Light Insulation & Ballast Repl.		592	115
G3	Boiler Improvements		7921	1825
G4	Condensate Line		4171	573

TABLE 1-13

Projected Energy Consumption After Project Implementations in FY85

Energy Sources	Units	Units Saved	MBtu Saved	Proj. Usage Units	Proj. Usage MBtu
Fuel Oil #6	Gals.	143,670	21,506	204,680	30,638
Fuel Oil #2	Gals.	38,298	5,312	52,616	7,297
Electricity	kWh	77,930	904	3,163,070	36,690
Elect. Demand	kVA	2949.8	-	6,590	-
Total			27,722		74,625

TABLE 1-14

PROJECTED ENERGY COSTS

	FY '84	FY '85	FY '86	FY '87
Electricity $/kWh	.0459	.0518	.0586	.0662
Fuel Oil #6 $/Gal	.84	.96	1.10	1.25
Fuel Oil #2 $/Gal	1.31	1.50	1.71	1.95

XIII. ENERGY PLAN

Table 1-15 gives the projects in order of SIR ratios with their associated energy savings (MBtu/YR) and Analysis Date Annual Savings ($/YR). This table provides a schedule for project implementation (ie, in order of highest to lowest SIR). Table 1-16 shows the estimated 1985 energy consumption (after all project implementations) and the percent reduction from 1975 energy consumption. Table 1-17 shows heating, cooling, lighting and other costs per square foot per year for the year 1985 and Table 1-18 gives the total project summary with all savings and SIR ratio. Table 1-19 shows which buildings are affected by each part of each project.

TABLE 1-15

			Savings	
		SIR	MBtu/YR	$/YR
A2c	Delamping	114.0	712	4200
A1d	Condensate Line Insul.	18.7	5720	24,825
A1c	Window Insulation	16.3	446	2744
G3	Boiler Improvements	16.2	1825	7921
A2a	Down-Blowers	13.0	6275	33,308
A1b	Overhead Door Insulation	8.4	167	825
A1f	DHW Heater Insulation	8.1	247	593
A1a	Roof/Ceiling Insulation	7.5	2525	14,316
A1g	Wall Insulation	5.0	2013	10,596
A1e	Valve Insulation	3.4	762	3307
A2b	Radiator Controls	1.9	1607	6974
B1	EMCS	1.9	3631	27,421
G4	Condensate Line Return	1.6	573	4171
G1	Crawlspace Insulation	1.1	231	1002
G2	Light Insulation & Ballast Replacement	1.1	115	592

TABLE 1-16

ENERGY PERCENT REDUCTION BY 1985

Energy Sources	1975 Consumption	1985 Consumption	% Reduction
Fuel Oil #6	419,782 gals.	204,680 gals.	51%
Fuel Oil #2	119,518 gals.	52,616 gals.	56%
Electricity	4,032,000 kWh	3,163,070 kWh	22%
Elect. Demand	10,818 kVA	6,590 kVA	39%
TOTAL ENERGY REDUCTION			40.8%

TABLE 1-17

ENERGY USAGE PER FT^2 1985
COMPARED TO 1975

	FY85	FY75
Heating	208,800 Btu/SF/YR	475,560 Btu/SF/YR
Cooling	53,250 Btu/SF/YR	67,818 Btu/SF/YR
Lighting	23,730 Btu/SF/YR	30,250 Btu/SF/YR
Miscellaneous (Dehumidified Buildings)	14,240 Btu/SF/YR	18,175 Btu/SF/YR

TABLE 1-18

PROJECT SUMMARY

	Projects	Analysis Date Construction Cost $	SIOH Cost $	Design Cost $	Energy Savings MBtu/YR.	Analysis Date Annual Savings $	Total Net Discounted Savings $	SIR
A1	Insulation/Weatherstripping							
	a. Roof/Ceiling Insulation	31060	1553	1864	2525	14316	233517	7.5
	b. Overhead Door Insulation	1495	75	90	167	825	12577	8.4
	c. Window Insulation	2850	143	171	446	2744	46338	16.3
	d. Condensate Line Insulation	18710	936	1123	5720	24825	349285	18.7
	e. Valve Insulation	13800	690	828	762	3307	46531	3.4
	f. Domestic Water Heater Ins.	1050	53	63	247	593	8495	8.1
	g. Wall Insulation	33530	1677	2012	2013	10596	166869	5.0
	h. Weatherstripping	27900	1395	1674	873	3789	53309	1.9
	TOTAL	130395	6522	7825	12753	60995	916921	7.0
A2	HVAC Modifications							
	a. Down-Blowers	30500	1525	1830	6275	33308	395801	13.0
	b. Radiator Controls	45675	2284	2741	1607	6974	85436	1.9
	c. Delamping	470	24	28	712	4200	53507	114.0
	TOTAL	76645	3833	4599	8594	44482	534744	7.0
B1	Energy Monitoring System	158287	7914	9497	3631	27421	301143	1.9
G1	Crawlspace Insulation	12860	643	772	231	1002	14094	1.1
G2	Light Insulation and Ballast Replacement	7010	351	421	115	592	7979	1.1
G3	Boiler Improvements	6000	300	360	1825	7921	97026	16.2
G4	Condensate Line	45000	2250	2700	573	4171	74794	1.6

TABLE 1-19

BUILDINGS AFFECTED BY PROJECTS

Bldg.#	Function	Increment A Projects												Increment B Projects				Increment G Projects					
		A1a	A1b	A1c	A1d	A1e	A1f	A1g	A1h		A2a	A2b	A2c		B-1			G-1	G-2	G-3	G-4		
1026	Tele. Exchange	X			X	X	X		X			X	X		X								
1030	Admin. Bldg.				X	X	X	X	X			X			X			X	X				
1031	Hospital		X		X	X	X		X			X	X		X			X	X				
1033	Navy Hq.				X	X	X	X				X	X		X								
1034	Auto Maint.	X	X	X	X	X	X	X			X		X		X								
1035	Craft Maint.	X		X	X	X	X	X			X				X								
1037	Laundry		X			X	X		X			X											
1038	Army Hq.				X	X	X		X			X			X			X	X				
1039	Lab																						
1048	Fire Station	X	X		X	X	X		X			X						X					
1048A	Guard Station				X				X			X			X			X	X				
1055	Gas Station																						
1060	Rec. Hall				X	X	X																
1061-2	Housing (15)					X	X		X														
T-4452	Pest. Storage						X					X			X								
44-16	Boiler House																			X			
U-4	Equip. Repair	X	X	X			X	X			X				X								
U-5	Equip. Repair	X	X	X			X	X			X				X								
1067	Equip. Repair	X			X	X					X		X		X								
L.L.6	Load Line 6																				X		

cont. TABLE 1-19

BUILDINGS AFFECTED BY PROJECTS

Bldg.#	Function	Increment A Projects													Increment B Projects					Increment G Projects					
		A1a	A1b	A1c	A1d	A1e	A1f	A1g	A1h		A2a	A2b	A2c			B-1				G-1	G-2	G-3	G-4		
804	Dehum. Storage															X									
805	Dehum. Storage															X									
806	Dehum. Storage															X									
807	Dehum. Storage															X									
DB-802	Denum. Storage															X									
809	Dehum. Storage															X									
810	Dehum. Storage															X									
831	Dehum. Storage															X									
832	Denum. Storage															X									
833	Dehum. Storage															X									
836	Dehum. Storage															X									
837	Dehum. Storage															X									
845	Denum. Storage															X									
847	Dehum. Storage															X									
850	Dehum. Storage															X									
851	Dehum. Storage															X									
852	Denum. Storage															X									
853	Dehum. Storage															X									
854	Dehum. Storage															X									
CC-1	Dehum. Boiler Hs.															X									
DC-1	Denum. Boiler Hs.															X									

cont. TABLE 1-19

BUILDINGS AFFECTED BY PROJECTS

Bldg.#	Function	Increment A Projects													Increment B Projects					Increment G Projects					
		A1a	A1b	A1c	A1d	A1e	A1f	A1g	A1h		A2a	A2b	A2c			B-1				G-1	G-2	G-3	G-4		
G-4	Dehum. Boiler Hs															X									
FE-17	Dehum. Boiler Hs															X									
52-15	Dehum. Boiler Hs															X									
51-25	Dehum. Boiler Hs															X									
WW-4	Denum. Water Work															X									
U-7	Dehum. Storage															X									
U-8	Dehum. Storage															X									
812	Dehum. Storage															X									
--	Sub Station															X									